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THE WAGE PRICE SPIRAL

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Abstract

This paper rehabilitates the old wage price spiral. It shows that, after an increase in aggregate demand, the process of adjustment of nominal prices and nominal wages results from attempts by workers to maintain or increase their real wage and by firms to maintain or increase their markups of prices over wages. Under continuous price and wage setting, the process of adjustment would be instantaneous ; under staggering of price and wage decisions, the adjustment takes time. The more inflexible real wages and markups are to shifts in demand, the higher is the degree of price level inertia, the longer lasting are the effects of aggregate demand on output.

For a long time, the "wage price spiral" was a central element of macroeconomic dynamics. An increase in aggregate demand, it was argued, would increase output and employment, leading firms to desire higher prices and workers higher wages; this would start a wage price spiral, which would end only if and when this "demand pull" inflation decreased real money balances sufficiently to return the economy to steady state. Or the spiral could start from a desire from workers to increase their real wages, or from firms to increase their profit margins, or from the attempts by both sides to maintain the same wage and price in the face of an adverse supply shock ; these would also start a wage price spiral, lead to "cost push" inflation, and through the effect of inflation on real money balances, lead to a recession[1].

With the advent of rational expectations, the wage price spiral left centerstage. With rational expectations, workers and firms had to understand that there could not be a simultaneous increase in all real wages and all markups (of prices above wages). The effect of an increase in aggregate demand was to increase nominal wages and prices simultaneously and instantaneously, in order to decrease real money balances and leave output unchanged. The same reasoning applied to supply shocks. : workers and firms had to understand that either real wages or profit margins or both had to decrease; the adjustment was instantaneous. Gone were the wage price spiral dynamics[2].

The proposition of this paper is that the wage price spiral should make a comeback, or more precisely that wage price spiral dynamics are likely to be present in any economy in which not all price and wage decisions are taken simultaneously. To make this point, the paper builds a model which is based on two main assumptions. The first is monopolistic competition in the goods and labor markets ; monopolistic competition gives the simplest acceptable price setting environment to examine such issues. The second is staggering of price and wage decisions. These two assumptions

together generate dynamics very similar to those described above . More precisely, in this model :

Price level dynamics are indeed the result of attempts by workers to maintain (or increase or decrease as the case may be) their real wage and by firms to maintain (or increase or decrease) their markups. Furthermore, there is a direct relation between the inflexibility of real wages and markups to shifts in demand and the degree of price level inertia. The smaller the effect of shifts in the demand for goods on the markup, and the smaller the effect of shifts in the demand for labor on the real wage, the more slowly will the nominal price level adjust to offset aggregate demand disturbances.

As the nominal price level adjusts slowly to its equilibrium value, changes in nominal money have long lasting effects on real money and aggregate demand. If movements in aggregate demand are not too large, in a sense to be made precise later, aggregate demand determines output : suppliers willingly accomodate the increased demand for goods and labor.

Finally, if the economy is predominantly affected by aggregate demand shocks, there is, as a first approximation, no relation between output and real wage movements. In response for example to an increase in nominal money, output temporarily increases before returning back to its equilibrium level ; during this adjustment process, the real wage is neither systematically lower nor higher but simply oscillates around its equilibrium value.

The paper is organised as follows. Section I characterises the equilibrium in the absence of staggering. Section II introduces staggering and characterises the dynamic effects of changes in nominal money. Section III presents conclusions and suggests extensions.

I. A Price Setting Model

If we are to introduce later staggering of price decisions, we must have a model in which price decisions are not taken by an auctioneer but by economic agents. As we want to focus on the real wage, we need a model with labor and goods markets. We want agents to choose prices and wages, but no single agent to choose either the aggregate price or wage level ; the simplest assumption is to have many goods, all of them imperfect substitutes, and many types of labor, all of them also imperfect substitutes. Thus, we choose a model with monopolistic competition in the goods and the labor markets.

1) The Price and Wage Rules

I have derived elsewhere the equilibrium of an economy with monopolistic competition in the labor and the goods markets, starting from utility and profit maximisation [Blanchard and Kiyotaki, 1985]. I shall start here directly from the demand functions and the equilibrium price and wage rules ; they are sufficiently simple and intuitive that little is lost by not reporting the details of the derivation.

There are m firms, each producing a different good, indexed by $i = 1,...,m$; good i has nominal price P_i. There are n unions, each supplying a different type of labor, indexed by $j = 1,...,n$ [3]; labor of type j has nominal wage W_j. The demand functions for each type of good i and each type of labor j are given by

$$(1) \quad Y_i = K_Y \, (M/P) \, (P_i/P)^{-\theta} \, ; \qquad \theta > 1; \qquad i = 1,\ldots,m$$

$$(2) \quad N_j = K_N \, (M/P)^{\alpha} \, (W_j/W)^{-\sigma} \, ; \qquad \alpha \geq 1; \; \sigma > 1; \qquad j = 1,\ldots,n$$

where the price and wage indices P and W are given by

$$(3) \quad P = \left(\frac{1}{m} \sum_{i=1}^{m} P_i^{\,1-\theta} \right)^{\frac{1}{1-\theta}} \, ; \quad W = \left(\frac{1}{n} \sum_{j=1}^{n} W_j^{\,1-\sigma} \right)^{\frac{1}{1-\sigma}}$$

The demand for good i, Y_i, is a function of real money balances (M/P) and of the nominal price P_i relative to the price level P, which is an index of all nominal prices. The elasticity of demand with respect to the relative price is given by θ.

The demand for type of labor j, N_j, is a derived demand by firms. It depends on the demand for goods and thus on real money balances ; α is the inverse of the degree of returns to scale and is thus the elasticity of the overall demand for labor with respect to real money balances. The demand for a specific type of labor j also depends on the nominal wage W_j relative to the nominal wage level W, which is an index of all nominal wages. The elasticity of demand with respect to the relative wage is given by σ. The letters K_Y and K_n are constants which depend on the parameters of technology and utility ; they play no important role in what follows.

The price and wage rules are given in turn by :

$$(4) \quad (P_i/P) = \left(K_p \, (\theta/(\theta-1)) \, (W/P) \, (M/P)^{\alpha-1} \right)^{\frac{1}{1+\theta(\alpha-1)}} \qquad i=1,\ldots,m$$

$$(5) \quad (W_j/W) = \left(K_w \, (\sigma/(\sigma-1)) \, (P/W) \, (M/P)^{\alpha(\beta-1)} \right)^{\frac{1}{1+\sigma(\beta-1)}} \qquad j=1,\ldots,n$$

Consider the price rule first. Each firm is a monopolist, facing a demand function given by equation (1). The price rule depends on two parameters, α and θ. The parameter α is the inverse of the degree of returns to scale to labor ; if firms acted competitively, $(\alpha-1)$ would be the elasticity of output supply with respect to the price. The parameter θ is the elasticity of demand with respect to the relative price. To guarantee the existence of an interior maximum to profit maximisation, α is assumed greater than or equal to unity and θ is assumed to be strictly greater than unity[4].

An increase in the real wage shifts the marginal cost curve upward, leading to an increase in the relative price. An increase in (M/P) shifts the demand curve out, leading under decreasing returns, to an increase in the relative price. Under constant returns however, the firm accomodates the increase at an unchanged relative price. The constant term has been written as the product of a constant K_p and a term $(\theta/(\theta-1))$ for reasons which will be clear below. K_p depends on the various structural parameters ; $(\theta/(\theta-1))$ is the ratio of price to marginal cost and reflects the degree of monopoly power of each firm in its market.

Consider now the wage rule. Each union is also a monopolist, maximising labor income minus the disutility of work, subject to the demand function for labor given by equation (2). The wage rule depends on two parameters, β and σ. $(\beta-1)$ is the elasticity of marginal disutility of work with respect to employment. The parameter σ is the elasticity of demand with respect to the relative wage. To guarantee the existence of an interior maximum to utility maximisation, β is assumed equal to or greater than unity, σ is assumed to be strictly greater than unity.

At a given relative wage W_j/W, an increase in W/P increases the real wage received by union j, W_j/P; this increase in the real wage leads the union to want to

supply more labor, thus to decrease its relative wage. Thus an increase in W/P decreases the relative wage (W_j/W). An increase in (M/P) increases the derived demand for labor and leads, under increasing disutility of work, to a higher relative wage ; if β is equal to unity however, the union supplies more labor at the same relative wage. The constant term is again separated in two terms ; the first depends on structural parameters and the second reflects the degree of monopoly power of each union in its market.

We shall later on be interested in fluctuations of aggregate output. Note that, from equations (1) and (3), aggregate output is given by

$$(6) \qquad Y \equiv (\sum_{i=1}^{m} P_i \ Y_i)/P \quad = K \ (M/P)$$

where K is a constant ; aggregate output is proportional to real money balances.

2) The Equilibrium

In equilibrium, symmetry, both across price setters and wage setters, implies that all relative prices and all relative wages must be equal to unity. Using P_i = P for all i and W_j = W for all j in equations (4) and (5) gives

$$(7) \qquad (P/W) \quad = (\theta/(\theta-1)) \ K_p \ (M/P)^{\alpha-1}$$

$$(8) \qquad (W/P) \quad = (\sigma/(\sigma-1)) \ K_w \ (M/P)^{\alpha(\beta-1)}$$

The first equation, which we shall refer to as the markup equation, gives the equilibrium relation between the markup of prices over wages and real money balances

[Figure 1.]

Figure 1.
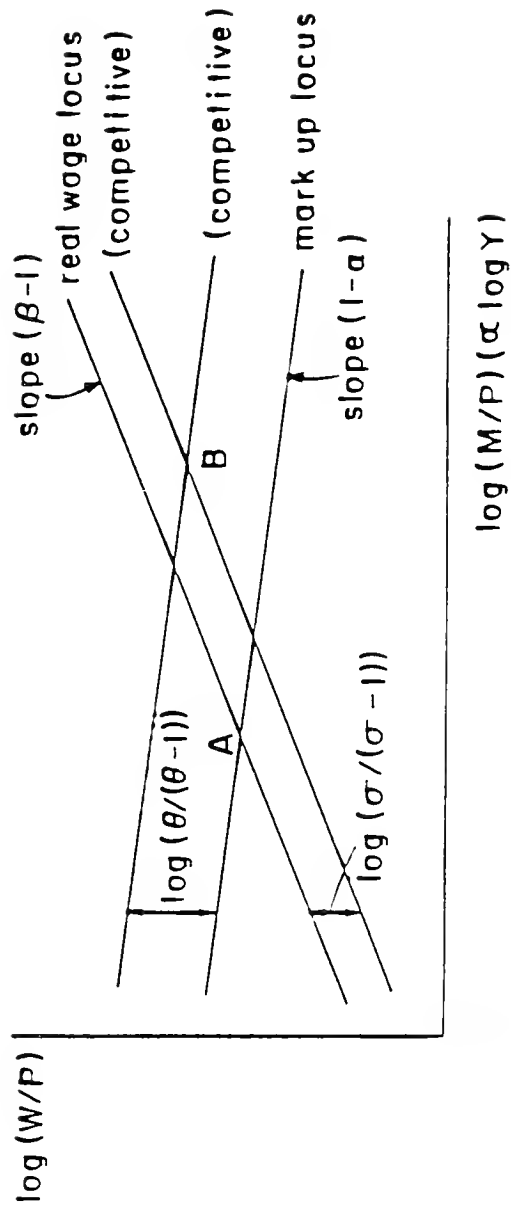
from the point of view of firms. Unless firms have constant returns ($\alpha=1$), an increase in real money balances increases aggregate demand and requires an increase in the markup.

The second equation, which we shall refer to as the real wage equation, gives the equilibrium relation between real wages and real money balances from the point of view of unions. Unless the marginal disutility of work is constant ($\beta=1$), an increase in real money balances increases the derived demand for labor and requires an increase in the real wage.

The equilibrium is characterised graphically in Figure 1. It is drawn in the log(W/P), log(M/P) space so that both the markup and the real wage loci are linear. If β is strictly greater than unity, the real wage locus is upward sloping ; if α is strictly greater then unity, the markup locus is downward sloping. The equilibrium determines the level of the real wage and the level of real money balances and is characterised by point A. Given equation (6), it determines output. Given nominal money, it determines the price level.

It is useful, for later reference, to compare this equilibrium with the equilibrium which would prevail if firms and unions had the same technology and objective functions, but took prices and wages as given, that is, did not exploit their monopoly power. We shall refer to this equilibrium as the competitive equilibrium. The competitive equilibrium is very similar to the monopolistically competitive one. The equations characterising it are identical to equations (7) and (8) except for the absence of ($\theta/(\theta-1)$) in the first and ($\sigma/(\sigma-1)$) in the second. Firms do not use their monopoly power, so that their mark up is lower at any level of output. Unions do not exert their monopoly power either, so that the real wage is lower at any level of employment. The competitive loci are drawn in Figure 1. The

competitive equilibrium is given by point B. Comparing B and A shows the
monopolistically competitive equilibrium to have lower output ; whether it has higher
or lower real wages is ambiguous.

Our ultimate goal is to better understand the presence and the nature of the
dynamic effects of nominal money on wages, prices and output. What have we gained by
introducing monopolistic competition ? In a way, we appear to have gained very little
; in the monopolistically competitive equilibrium, just as in the competitive
equilibrium, nominal money is still neutral, leading to an instantaneous proportional
increase in wages and prices, and leaving output unchanged.

In another way, we are very close to having gained something. To see this, and
as an introduction to the next section, it is useful to rewrite equations (7) and (8)
in logarithmic form and to characterise the equilibrium in the price wage space.
Denoting by lower case letters the logarithms of upper case letters, equations (7)
and (8) become, with some reorganisation

(9) $p = c_p + a w + (1-a)m$; $a \equiv 1/\alpha$, $a \in (0,1]$

(10) $w = c_w + b p + (1-b)m$; $b \equiv 1-\alpha(\beta-1)$ $b \leq 1$

where $c_p \equiv (\log(\theta/(\theta-1)) + \log(K_p))/\alpha$ and $c_w \equiv \log(\sigma/(\sigma-1)) + \log(K_w)$

The markup equation gives the nominal price as a linear combination of the
nominal wage and nominal money[5]. The coefficient on the wage, a, is the degree of
returns to scale. Unless firms operate under constant returns, an increase in m will
increase p given w.
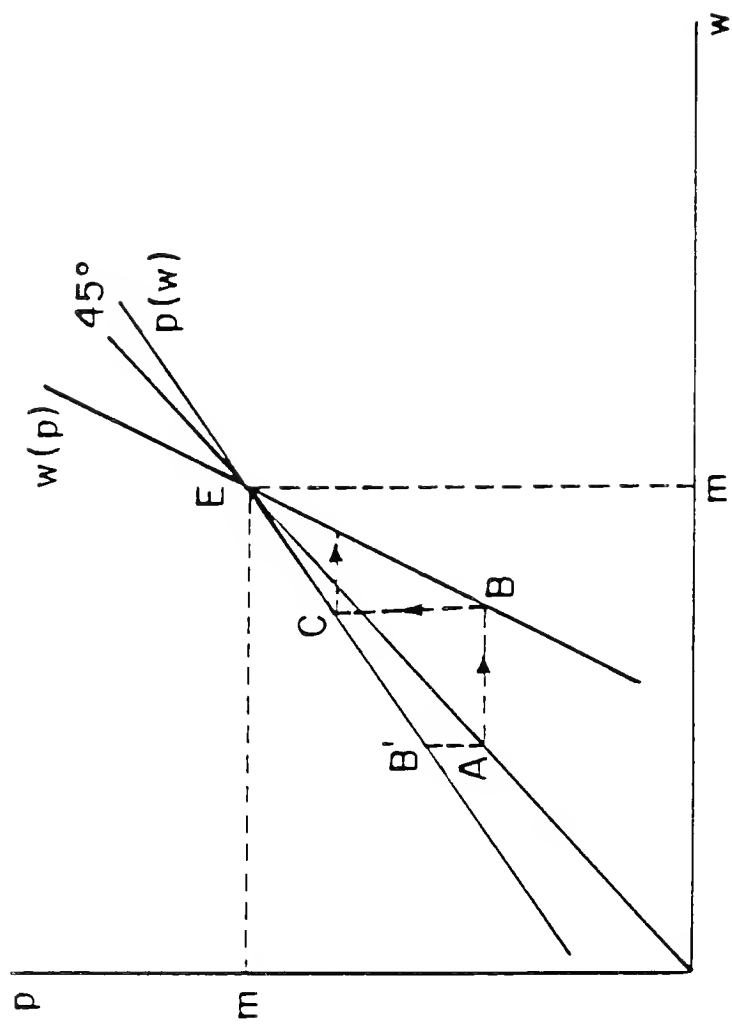
[Figure 2]

The real wage equation gives the nominal wage as a linear combination of the nominal price and nominal money. The coefficient on the price, b, is less than unity but is not necessarily positive. An increase in the price level, which decreases real money balances and the demand for labor, requires a decrease in the real wage. If α and β are large enough, it may even require a decrease in the nominal wage. If both α and β are close to unity, a and b are also close to unity. If a and b are close to unity, shifts in demand have little effect on markups and real wages respectively ; we shall in what follows refer to a and b as reflecting the degrees of inflexibility of markups and real wages respectively

The equilibrium is characterised in the p, w space in Figure 2, for a given value of m. The price rule has slope less than or equal to one ; if b is positive, the wage rule has slope greater than or equal to one. The equilibrium is given by point E.

It is useful for later to give a heuristic description of how this equilibrium may be reached through a tatonnement process. Suppose that nominal money increases, so that in Figure 2, the initial equilibrium is at A and the new equilibrium at E ; at initial values of w and p, aggregate demand increases, increasing output and employment. Workers therefore, want a higher real wage. Given p, they want to go to point B. Firms want a higher markup ; given w, they want to go to point B'. These two claims are obviously inconsistent. Attempts by workers and firms to increase real wages and markups only lead to increases in nominal wages and prices. This process ends when both nominal prices and wages have increased in proportion to nominal money so that real money balances are back to their previous level ; desired real wages and desired markups are then again consistent and equilibrium is reached. A possible path of adjustment in which prices and wages adjust in turn is ABC..E in Figure 2. In this

case, the less flexible real wages and mark ups, the slower the adjustment process.
This is only a tatonnement process ; we shall now see that staggering leads to a
similar process in real time.

II. Staggering and Demand Fluctuations

Most nominal prices -and wages- are set for discrete periods of time. For each
such period, price setters prefer the simplicity of a constant nominal price to both
a contingent price path or even a predetermined -but not necessarily constant- price
path. Moreover, nominal price changes do not take place all at the same time but
rather uniformly through time. This may be partly because of strategic timing
considerations on the part of some price setters. More often, it is simply the
unavoidable consequence of the existence of a large number of uncoordinated price and
wage setters. Sometimes predetermined prices or wages are part of explicit contracts;
more often, they are not.

The implication is that wage or price setters, when they change their wage or
price, experience a change in their relative wage or relative price. The actual
process of adjustment to a nominal shock is a complex one, involving changes in
relative wages, relative prices and real wages. To study it and keep the analysis
manageable, one must focus on one particular aspect of that process. One may for
example, concentrate on the interaction among price decisions, assuming continuous
wage setting ; this was done by Akerlof [1969]. One may instead concentrate on the
interaction among wage decisions, the "wage wage spiral", assuming continuous price

setting, as was done by Taylor [1980]. Given our focus on the "wage price spiral", we focus on the staggering between wage decisions on the one hand and price decisions on the other.

1) Price and Wage Rules Under Staggering

This leads us to formalize the staggering of decisions in the following rather mechanical but convenient way :

Time is discrete. The economy is described in the same way as before , except for price and wage setting[6]. All price decisions are taken every two periods, at even times. Thus, nominal prices are set at time t for periods t and t+1, and so on. Wage decisions are taken every two periods, at odd times, thus at t-1 for t-1 and t, and so on. The unit period should be thought as fairly short, say of the order of a month, so that after two months all price and wage decisions have all been freely revised. The length of the period during which prices and wages are fixed is taken as exogenous and so is the staggering structure[7].

Firms and workers are assumed to satisfy demand at the quoted prices and wages ; we shall return to this assumption below and characterize the conditions under which it is indeed optimal for them to do so.

As all firms take price decisions at the same time, they all choose the same price. It is given by

(11) $p_t = (1/2)[(a\ w_{t-1} + (1-a)m_t) + (a\ E(w_{t+1}|t) + (1-a)E(m_{t+1}|t))]$

where the constant term is ignored for notational simplicity. E(It) denotes the expectation of a variable conditional on information available at time t. p_t denotes the nominal price chosen at time t for t and t+1 ; similarly w_{t-1} denotes the nominal wage chosen at time t-1 for t-1 and t and is therefore the nominal wage still prevailing at time t. Equation (11) is the natural extension of (9); it states that the nominal price is a weighted average of the optimal price for time t, which depends on the current nominal wage and current nominal money, and of the expected value of the optimal price for t+1, which depends on expectations of the nominal wage and nominal money for time t+1[e]. Equation (11) implies that for each interval during which the nominal price is fixed, the expected average markup is a non decreasing function of expected average aggregate demand.

As all wage setters decide about wages at the same time, all wages are the same. In a way similar to prices, the nominal wage chosen at time t-1 for example is given by

(12) $w_{t-1} = (1/2)[(b\ p_{t-2} + (1-b)m_{t-1}) + (b\ E(p_t|t-1) + (1-b)E(m_t|t-1)]$

where the constant term is again ignored, for notational simplicity. The nominal wage chosen at time t-1 is a weighted average of (1) the optimal wage for time t-1, which depends on p_{t-2}, the price level still prevailing at time t-1, and on nominal money at time t-1, and (2) of the expected optimal wage for t, which depends on the price level and nominal money expected to prevail at time t, as of time t-1. Equation (12) implies that, for each period during which the nominal wage is fixed, the expected average real wage is a non decreasing function of the expected average aggregate demand for labor.

The dynamic behavior of the economy is now characterised by equations (11) and (12), and a specification of the money process. I solve the system for a general process for money in the appendix; in the text, I focus on the effects of an unanticipated permanent increase in nominal money. It is a counterfactual and unexciting experiment but one which shows most clearly the dynamics of the system.

2) The Adjustment of The Price Level

Starting from steady state, nominal money increases at time t=0, from zero to dm (by appropriate normalisation). The increase is both unanticipated and permanent. What are its effects on prices over time ?

The answer is easy to derive under static expectations and helps develop the intuition. Using (11) and (12) gives in this case

$$p_0 = (1-a)\ dm$$
(13)
$$p_t = ab\ p_{t-2} + (1-ab)dm\ ;\ t = 2,4,\ldots$$

At time t=0, after the increase in money, wages have not yet increased : firms increase their nominal price only to the extent they want to increase their markup to supply the higher level of output. Under constant returns, there is no increase at time t=0 as a=1. At time t=1, wages increase both because prices are higher and because, unless b=1, a higher real wage is required to supply a higher level of labor. At time t=2, prices adjust again and so on.

We can think of the coefficient on p_{t-2} as the degree of price level inertia ; if it is close to one, nominal prices adjust slowly to an increase in nominal money. Thus, under static expectations there is a direct relation between the degree of price level inertia, ab, and the inflexibility of mark ups and real wages, as

measured by a and b. The more inflexible markups and real wages, the higher the degree of price level inertia.

Under rational expectations, the price level path is instead given by (see Appendix)

$$p_0 = (1 - (1/2)a [1 - (1/4)ab(1+\lambda)])^{-1} dm, \qquad 0 \leq p_0 \leq 1-\lambda$$

$$p_t = \lambda p_{t-2} + (1-\lambda)dm \quad ; \qquad t=2,4,\ldots$$

(14)

where $\lambda \equiv (1-\sqrt{(1-ab)})/(1+\sqrt{(1-ab)})$ and λ has the following properties

$$\lambda \leq ab \; ; \; \lambda = 0 \text{ if } ab = 0, \; \lambda = 1 \text{ if } ab = 1$$

The initial jump in nominal prices is larger than under static expectations. The degree of price level inertia is now given by λ rather than by ab. λ is an increasing function of ab, but is smaller than ab. That the adjustment should be faster under rational expectations is obvious : at time t=0 for example, price setters take into account not only the increase in demand but the forthcoming increase in nominal wages at time t=1. Along the path, price and wage setters take account of current demand and current prices and wages, but also of expected increases in prices and wages. Although the adjustment is faster under rational expectations, there is still a direct relation between the inflexibility of markups and real wages, measured by a and b, and the degree of price level inertia, measured by λ^o. The process of adjustment is well described as a wage price spiral in which the speed of the spiral depends on the desire of workers and firms to increase or maintain their real wages and markups in response to the increase in demand.

A numerical example of a path of adjustment is given in table 1, for a = b = 0.99.

Table 1
The Effects of an Increase in Money on Relative and Nominal Prices.

Time	p	w	w-p	y	average real wage*	average mark up**
0	0.133	0.0	-0.133	0.877	-0.076	
						0.009
1	.133	.247	.144	.877		
					.007	
2	.346	.247	-.100	.654		
						.007
3	.346	.432	.085	.654		
					.005	
4	.508	.432	-.076	.492		
						.006
5	.508	.572	.064	.492		
					.003	
6	.629	.572	-.057	.371		
						.004
7	.629	.678	.049	.371		
					.003	
8	.721	.678	-.043	.279		
						.003
9	.721	.757	.036	.279		
					.002	
10	.790	.757	-.033	.210		
						.003
11	.790	.817	.027	.210		
					.001	
12	.842	.817	-.025	.158		
						.002

a = b = 0.99

All numbers in the table should be multiplied by dm

* The "average real wage" is the average value of the real wage for the two period interval during which the nominal wage is fixed.
** The "average mark up" is the average value of the mark up during the two period interval during which the nominal price is fixed.

3) Real wages during the adjustment process

We start with a puzzle. After the increase in money, price setters desire a higher markup, wage setters a higher real wage. Under static expectations, both sides fail to take into account future movements in either prices or wages and are systematically disappointed. This cannot happen however under rational expectations ; in particular, as there is no unanticipated movement in money after t=0, the rational expectation path is, after t=0, a perfect foresight path. Thus, as equations (11) and (12) hold for actual values of prices and wages, it must be the case that workers must, for every interval during which nominal wages are fixed, obtain a higher real wage ; firms on the other hand must also, for every interval during which nominal prices are fixed, obtain a higher markup. How can these be consistent ?

Table 1 shows that they can be indeed be consistent (the algebra is given in the appendix). They can be consistent because the two intervals described above do not coincide but overlap : there is then a path of increases in nominal prices and wages such that the average markup and the average real wage are higher in turn. This paradoxical path is the result of the assumption of rational expectations ; the relevant result is not the paradox, but the existence of a rational expectation path.

The other and directly related characteristic of the process of adjustment is that there is no persistent deviation of the real wage from its equilibrium value : the real wage simply oscillates around this value as output returns to equilibrium[10]. It is the very nature of the process of adjustment under staggering of wage and price decisions which implies that there be no systematic relation between real wages and output in response to demand shocks.

The two paths of adjustment, under static and rational expectations are represented in Figure 3, the static expectation path by the dotted line, the rational
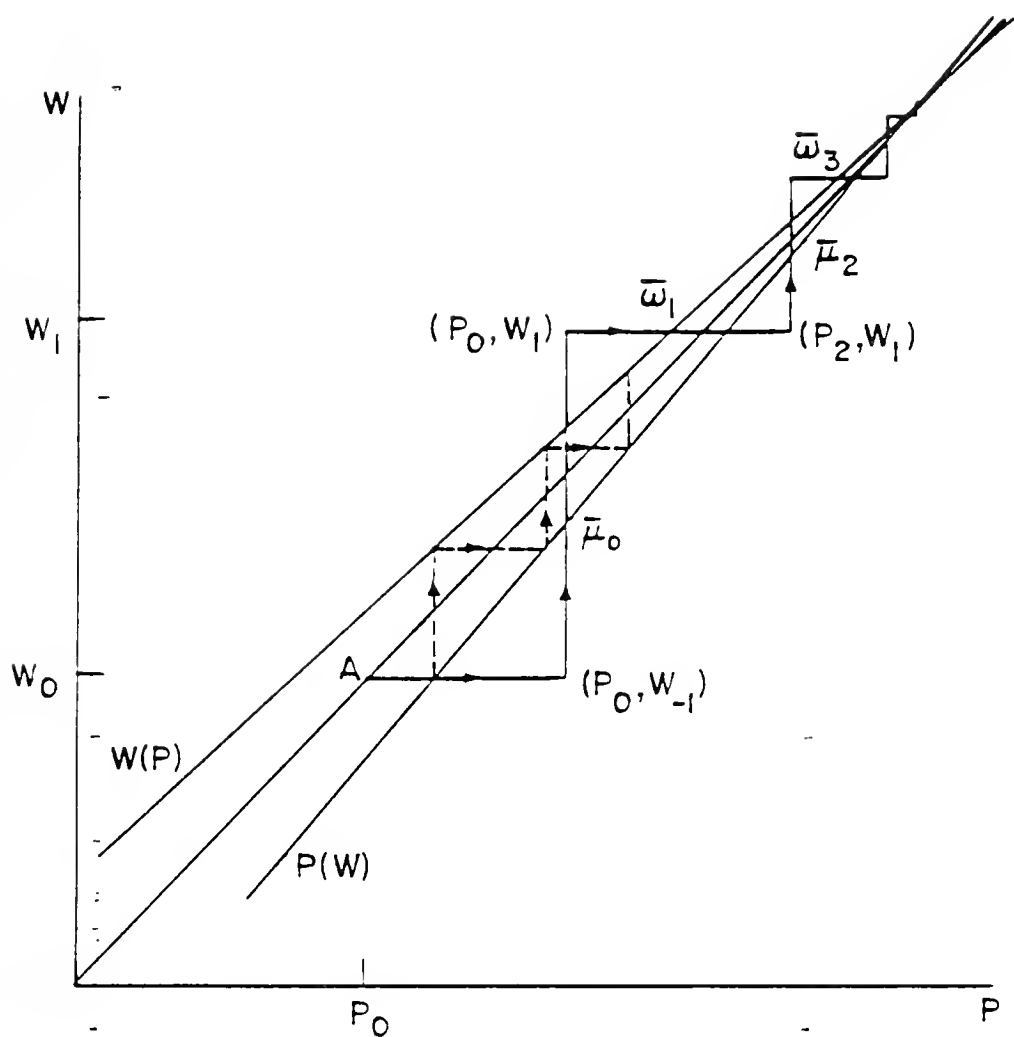
[Figure 3]

expectation path by the thick line. Note that the average nominal wage, denoted by ω,
is always on the w(p) locus, the average nominal price, denoted by μ, is always on
the p(w) locus.

4) Aggregate Demand and Output

Until now we have assumed that firms and workers satisfy demand, so that along
the path of adjustment, output and employment are proportional to real money
balances. This may not be the case ; even after a monopolist has set a price, it has
the option of either supplying or rationing demand. To see when aggregate demand
determines the outcome, we must return to Figure 1 which is redrawn for convenience
as Figure 4.

The labor market equilibrium condition under monopolistic competition, which
gives real wages as an increasing function of real money, is drawn as LL ; the goods
market equilibrium condition, which gives markups as an increasing function of real
money, is drawn as GG. The path of adjustment following an increase in nominal money
is given by ABC...E : after an increase of nominal money, price setters increase
prices, increasing markups and decreasing real money balances, so that the economy
goes to point B ; in the following period, wage setters take the economy to point C
and so on.

Let us now draw the equilibrium loci under perfect competition, i.e if neither
firms nor unions exert their monopoly power . The labor market equilibrium locus is
drawn as L'L', implying a lower real wage at any level of output, the goods market
equilibrium is drawn as G'G', implying a lower markup at any level of output.
Consider now point F on the GG locus, which gives the monopolistically competitive
mark up at a given level of demand ; we can ask by how much we can decrease the

[Figure 4]

log(w/p)

G'
L
G
E
C
A
B
F'
F
G'
L'
L'
G

log(M/p)
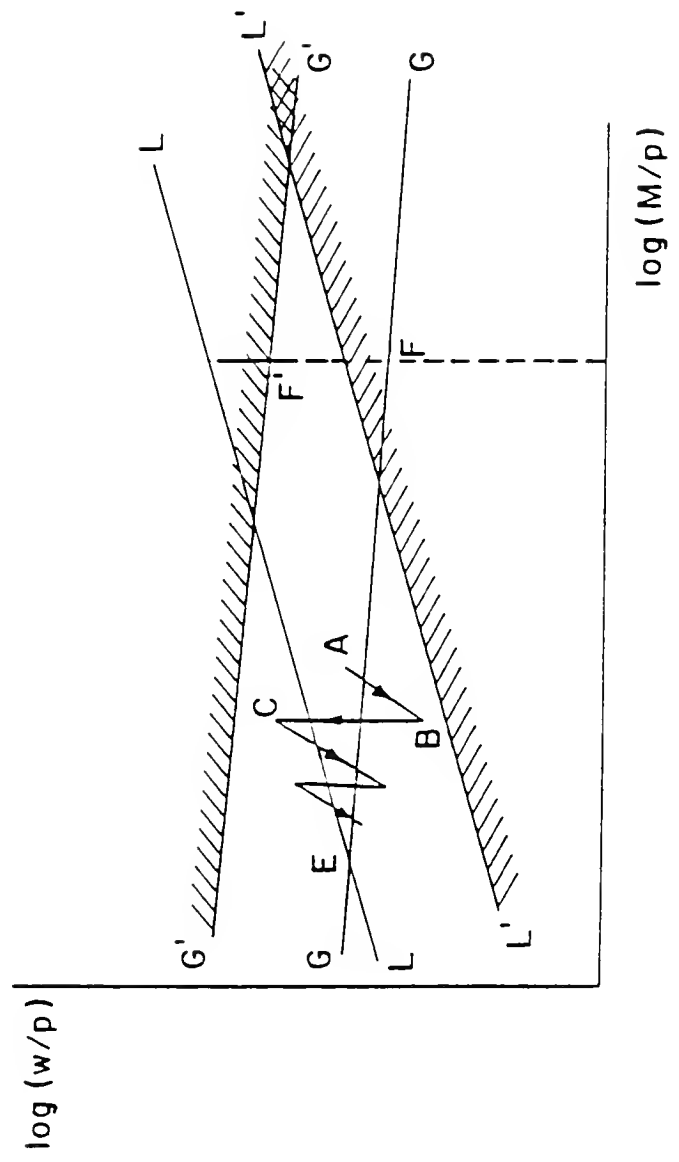
markup, and still have firms willing to supply this given level of demand. The answer is that we can decrease the markup until price equals marginal cost ; this happens precisely on the competitive equilibrium locus, at point F'. If we decrease the markup further, firms will ration demand. The same reasoning applies to workers ; at any level of employment we can decrease the real wage until it reaches its competitive equilibrium value. Let us shade the region to the right of either L'L' or G'G'. In this shaded region, either firms or workers or both will ration demand ; outside of this region, they will both satisfy it.

Thus, demand will determine output and employment if the path of adjustment lies entirely in the non shaded region. This is the case for the path drawn in Figure 4. If there is some monopoly power in both goods and labor markets, we know that the monopolistically competitive equilibrium lies strictly inside that region, so that small enough increases in money will leave the path of adjustment entirely within the region ; whether this is the case for larger movements in money will depend in general on the degree of substitution between goods and between labor types, as this determines the degree of monopoly power and the size of the region, and on the size of the change in nominal money and the parameters a and b, as they determine the size of real wage movements during the process of adjustment. Values of a and b close to unity imply small oscillations of the real wage and the markup, and thus make it more likely that the path of adjustment remains outside the shaded region. Small values of θ and σ increase the amount the monopoly power of firms and workers respectively, increase the size of the non shaded region and thus also make demand determination of output more likely.

Note that monopolistic competition plays an important role here and does more than provide a convenient price setting environment. To get demand determination of

output to both decreases and increases in demand, at least within some bounds, one needs to start from an equilibrium in which, for whatever reason, price exceeds marginal cost and the wage exceeds marginal utility of leisure. This is what monopolistic competition provides here.

To summarize the results of this section, movements in money create, at the initial pair of prices and wages, desired changes in relative prices (the real wage and its inverse, the markup). After an increase in money, both relative prices are too low : firms desire a higher markup, unions a higher real wage ; after a decrease in money, they are both too high. As workers and firms reestablish in turn their desired relative prices, nominal prices and wages adjust until aggregate demand returns to its equilibrium value. If relative prices are relatively inflexible, the movement of nominal prices is slow. During the process of adjustment, the real wage oscillates around its equilibrium value. During the process of adjustment, movements in aggregate demand, if they are not too large, determine output which returns monotonically to its equilibrium value.

III. Conclusion

We have seen that the process of adjustment of nominal prices to a change in aggregate demand is well described as a wage price spiral. After an increase in demand, attempts by workers and by firms to maintain or increase real wages and mark ups lead to a general increase in nominal prices and wages which last until output is back to its equilibrium value. The smaller the desired increase in relative prices, the slower the wage price spiral, the higher the degree of price level inertia.

There are at least two directions in which the model presented in this section should be extended. The first is relatively straightforward and involves looking at a richer menu of shocks, monetary policies and staggering structures :

The model generates more interesting wage price dynamics if we allow for monetary policy to respond to wage and price developments. Suppose for example that, after the initial increase in nominal money, the monetary authority attempts to maintain the higher level of output by partially accomodating the increase in nominal prices. In this case, the higher the degree of accomodation, the stronger and the longer lasting the wage price spiral. The monetary authority is indeed able to maintain output at a higher level for a longer period of time but at the cost of a higher initial increase in prices and a longer period of inflation. What the model does not easily generate however is an accelerating wage price spiral. In the example sketched above , the rate of inflation is largest at the beginning, when output and employment are highest and desired increases in real wages and mark ups are largest, and then decreases over time as output returns to normal. As the degree of accomodation goes to unity, that is as the monetary authority accomodates one for one nominal price increases, the result is not high inflation but an infinite value of

the price level at the time of the initial increase in money. Learning by agents over time of the goals of the monetary authority is needed to generate accelerating inflation.

We have focused only on demand shocks. The model can be used to look at the effects of supply shocks instead, be they technological shocks , a union cost push or other shocks to labor supply. An adverse technological shock requires a decrease in the real wage and a decrease in output. At the initial level of output, real wages and mark ups are inconsistent. This starts a wage price spiral which stops when real money balances and output have decreased to the new equilibrium level. Here again, efforts by the monetary authority to slow the decrease in output lead to more inflation along the path of adjustment.

Finally, one would want to study the effects of more realistic staggering structures, and in particular to relax the assumption of simultaneous price decisions and simultaneous wage decisions. This can be done by extending the continuous staggering structure suggested by Calvo [1982]. Staggering of price decisions implies that the elasticity of demand with respect to relative prices will now affect the speed of adjustment of the price level. Staggering of wage decisions implies that the elasticity of demand with respect to relative wages will also affect the speed of adjustment of the price level[11].

The second set of extensions is more difficult and more important.

For the model presented here to generate large and prolonged effects of aggregate demand, both α and β must be close to unity : firms must be willing to supply more output at a slightly higher markup, and unions must be willing to supply more labor at a slightly higher real wage. This seems indeed to be true :

microeconomic evidence on markups suggest that they respond weakly to shifts in the demand for goods and evidence on real wages suggest that real wages respond weakly and slowly to shifts in demand for labor. But there are serious issues in reconciling this observed behavior with what we know about technology and tastes :

In our model, a constant desired markup (a =1) is indeed justified if marginal cost is constant (α=1). But there is much evidence that short run marginal cost is not constant : inventory behavior points to substantial costs of changing production [Blanchard 1983], overtime payments, incurred because of costs of changing the number of workers employed, point to increasing short run marginal cost [Bils 1985].

In our model, a constant desired real wage (b=1) is justified if the marginal disutility of employment is constant (β=1) . If fluctuations in employment are equally shared among workers, and if unions maximize the utility of their representative members, then β-1 corresponds to the inverse of the individual labor supply elasticity with respect to the real wage. There is substantial microeconomic evidence however that this elasticity is small, that the individual (β-1) is large. This suggests two directions of research, both aimed at explaining why b may be close to unity. The first, which has a long tradition, is to explain why the unions' β may be smaller than individual β's. The second, which is now the subject of active research, is to study the role of contracts in labor markets, and to see whether contracts can explain why real wages seem to respond little to movements in employment. If contracts take for example the form of free determination by the firm of the level of employment subject to an agreed upon real wage employment schedule, and if this real wage employment schedule is relatively flat, the qualitative results of the paper are likely to go through[12].

Appendix

1)The Behavior of the Price Level

The behavior of prices is first derived for a general process for money, and then for the specific process described in the text.

Using equation (12) for both t-1 and t+1, taking $E(w_{t+1}|t)$ using iterated expectations and replacing in (10) gives

$$p_t = (1/4) \; ab \; [p_{t-2} + E(p_t|t-1) + p_t + E(p_{t+2}|t)] + (1/4)z_t$$

where z_t is given by

(A1)
$$z_t \equiv a(1-b)[m_{t-1} + E(m_t|t-1) + E(m_{t+1}|t) + E(m_{t+2}|t)]$$
$$+ 2(1-a)[m_t + E(m_{t+1}|t)]$$

Equation (A1) must be solved in two steps. The first is to solve for $E(p_t|t-1)$, the second for p_t. Denote by a star the expectation of a variable conditional on information available at time t-1. Then taking expectations of both sides conditional on information available at time t-1 and rearranging gives

(A2) $ab \; p*_{t-2} + (2ab-4) \; p*_t + ab \; p*_{t+2} = -z*_t$

Let λ be the smallest root of $ab\lambda^2 + (2ab-4)\lambda + ab = 0$, so that

$$\lambda = (1 - \sqrt{(1-ab)})/(1 + \sqrt{(1-ab)})$$

This root is an increasing function of ab, equal to 0 for ab=0 and to 1 for ab=1. Solving (A2) by factorization, subject to the constraint that p_t does not explode, gives

$$(A3) \quad p*_t = \lambda \, p*_{t-2} + (\lambda/ab) \sum_{i=0}^{\infty} \lambda^i \, z*_{t+2i}$$

so that

$$E(p_t|t-1) = \lambda \, p_{t-2} + (\lambda/ab) \sum_{i=0}^{\infty} \lambda^i \, E(z_{t+2i}|t-1)$$

The second step is to solve for p_t. Deriving $E(p_{t+2}|t)$ from (A3) and replacing $E(p_{t+2}|t)$ and $E(p_t|t-1)$ in (A1) gives p_t :

$$(4-ab(1+\lambda))p_t = ab(1+\lambda)p_{t-2} + z_t + \lambda \sum_{i=0}^{\infty} \lambda^i \, [E(z_{t+2i}|t-1)+E(z_{t+2i+2}|t)]$$

I now consider the specific path of money described in the text. m increases at time t=0 from 0 to dm ; the increase in unanticipated and permanent.

To solve for the price path, note that for t>0, there is no uncertainty and thus (A3) holds for actual values of p and z rather than for their expectations. Note also that, for t>0

$$(\lambda/ab) \sum_{i=0}^{\infty} \lambda^i \, z_{t+2i} = (1-\lambda)dm, \text{ so that}$$

$$p_{t+2} = \lambda \, p_t + (1-\lambda)dm \quad \text{for } t \geq 0$$

This gives in particular, for t=0, p_2 as a function of p_0. Equation (A1) in turn provides, for t=0, another relation between p_0 and p_2. Noting that $E(p_0|-1)=0$ and $E(p_2|0)=p_2$, we have

$$(1-(1/4)ab) \ p_0 = (1/4)ab \ p_2 + [1-a +(1/2)a(1-b)]dm$$

Solving the two equations in p_0 and p_2 gives the following characterization of the price level path :

$$p_0 = \{1 - (1/2)a [1 - (1/4)ab(1+\lambda)]^{-1}\}dm$$

$$p_t = \lambda \ p_{t-2} + (1-\lambda)dm \qquad for \ t=2,4,\ldots$$

2) The Behavior of the Real Wage

Let x_t be the real wage at time t ; from equation (12) at time t-1 and t+1, and from the above characterization of prices,

$$x_0 \equiv w_0 - p_0 = - p_0 < 0$$

$$x_{t+1} \equiv w_{t+1} - p_t = [(1/2)b(1+\lambda)-1](p_t - dm)$$

$$a,b \leq 1 \Rightarrow (1/2)b(1+\lambda) - 1 < 0 \Rightarrow x_{t+1} > 0$$

$$x_{t+2} \equiv w_{t+1} - p_{t+2} = [(1/2)b(1+(1/\lambda)) - 1](p_{t+2} - dm)$$

From the definition of λ, we have

$$(1+(1/\lambda)) = 1 + (1 + \sqrt{(1-ab)})/(1 - \sqrt{(1-ab)}) = 2/(1 - \sqrt{(1-ab)})$$

so that $(1/2)b(1+(1/\lambda)) = b/(1 - \sqrt{(1-ab)})$

$$a \leq 1 \Rightarrow (1/2)b(1+(1/\lambda)) \geq ab/(1 - \sqrt{(1-ab)})$$

$$ab = (1 - \sqrt{(1-ab)})/(1 + \sqrt{(1-ab)}) \Rightarrow$$

$$(1/2)b(1+(1/\lambda)) - 1 \geq (1 + \sqrt{(1-ab)}) -1 = \sqrt{(1-ab)} \geq 0 \Rightarrow x_{t+2} < 0$$

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Footnotes

[1]

See for example "A Survey of Inflation Theory," by M. Brofenbrenner and F. Holtzman, written in 1965.

[2]   This point was in fact made many years before the rational expectation "revolution" by W. Fellner (1959, pp 235-236).

[3]   The model is agnostic as to whether unions are maximising the utility of their representative member, or maximising some other objective function. This however affects the interpretation and the likely value of the parameter β below, raising an issue to which we shall return later.

[4]   As we take the number of firms as given, we do not need to introduce explicitly the fixed cost faced by each firm. The analysis in the text is consistent with the presence of such a fixed cost. Thus while we rule out decreasing marginal cost, we do not rule out decreasing average cost.

[5]   Whenever we refer to the nominal price, the reader is to understand, whenever relevant, the logarithm of the nominal price. The same applies to the nominal wage and nominal money.

[6]   In the absence of staggered price and wage setting, the equilibrium, each period, is the equilibrium described in Section I. Thus, dynamics arise in this model only from the presence of staggered price and wage setting. Eliminating all other sources of dynamics allows to focus more simply on the dynamic effects of price and wage staggering.

[7]   The staggering structure we consider is particularly vulnerable to the criticism that it would not survive endogenization of staggering decisions. It is clearly in the interest of firms to coordinate price changes with wage changes. Replacing the

decisions would be more attractive in this respect. It would however complicate the

algebra substantially. For further discussion and work on endogenous staggering, see

Fethke and Policano (1984)

e   Equation (11) is <u>not</u> the rule which comes out of expected profit maximisation by

firms over periods t and t+1, subject to the constraint that the nominal price be the

same in both periods, and the equilibrium condition that all relative prices be equal

to one. It may be useful to compare the two rules in the simple case of constant

returns to scale.

Under constant returns, (11) reduces to :

$$p_t = (1/2) \ (w_{t-1} + E(w_{t+1}|t))$$

whereas the price obtained from explicit profit maximisation is, assuming the

discount factor on second period profit to be equal to β (letters now denote levels,

not logarithms):

$$P_t = K_p \ [(M_t/(M_t+\beta E(M_{t+1}|t)))W_t + (\beta E(M_{t+1}W_{t+1}|t)/(M_t+\beta E(M_{t+1}|t)))]$$

Comparing the two expressions shows three main differences. The first is the presence

of the discount rate. The second is the presence of the covariance of M and W at t+1.

The third is that P_t is an arithmetic rather than a geometric average of W at time t

and t+1. An other way of stating the differences between the two rules is that, under

the correct rule, the price is an average of current and expected wages, with weights

which depend on current money and the joint disribution of future money and future

nominal wages.

If the unit period is short, so that β is close to one and $E(M_{t+1}|t)$ is close to M_t,

then (11) is a good approximation to the correct price rule. Our reason for using

that the approximation is not the source of the results we focus on.

9   This suggests that explaining the behavior of relative prices, quite apart from nominal rigidities should be high on the research agenda. This appears indeed to have been the approach followed in the 1960's (as summarized by Tobin [1970] for example). Research was focused on documenting and explaining the slow and small reaction of wages to unemployment, the slope of the short run Phillips curve, or the inflexibility of mark ups. Nominal price and wage inertia were then obtained not from staggering but from assumptions about expectations.

10   The oscillations are partly the result of the simple staggering structure we use. For more complex structures, such as continuous uniform staggering of price and wage decisions, the aggregate real wage may not oscillate at all.

11   One can also allow for an n-step (rather than one-step as in the text) production process and allow for staggering of price decisiosn along the production process. This has two relevant implications. It increases the degree of price level inertia and may generate systematic movements in the structure of relative prices in response to changes in nominal money. See Blanchard [1983].

12   Akerlof and Yellen [1985] have recently constructed a macroeconomic model along these lines ; they formalize the labor market as characterized by efficiency wages.

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